Savannah River Site
Solid Waste Management Department
Consolidated Incinerator Facility Project
Operator Training Program

FIRE PROTECTION/FIRE DETECTION AND ALARM (U)

Study Guide

ZIOITX21

Revision 01

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Training Manager / Date

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Engineering Manager / Date

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Facility Manager / Date

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REVISION LOG

REV.	AFFECTED SECTION(S)	SUMMARY OF CHANGE
01	All	New Issue

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1. 261-SOP-FDAS-01, Fire Detection and Alarms Procedure, Rev. 0D

2. 261-SOP-FP-01, Fire Protection Procedure, Rev. 0D

3. CIF-AP-3103, *CIF Fire Protection Plan*

4. DOE Order 5480.7, *Fire Protection*

5. DOE Order EP-0108, *Fire Protection for DOE Electronic Computer/Data Processing System*

6. Fire Protection/Fire Detection (FP/FDAS) System Design Description, Rev. 0

7. NFPA, *National Fire Codes* - 1988

8. Drawing MM6H 4743 - *Fire Protection Dry System, Sheet* 1

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15. WSRC-SA-17, *Consolidated Incineration Facility Safety Analysis Report*, DOE Approval Copy, 12/95

16. WSRC-2Q, *Fire Protection Program Manual*

LEARNING OBJECTIVES

TERMINAL OBJECTIVES

1.00 Given the necessary procedures, **OPERATE** the Fire Protection/Fire Detection and Alarm System (FP/FDAS) during normal operations to support the safe, efficient operation of the Consolidated Incineration Facility (CIF).

2.00 Given the necessary procedures, **OPERATE** the Fire Protection/Fire Detection and Alarm System (FP/FDAS) during abnormal, and infrequent operations to support the safe, efficient operation of the Consolidated Incineration Facility (CIF).

ENABLING LEARNING OBJECTIVES

1.01 **STATE** the purpose of the Fire Protection/Fire Detection and Alarm System (FP/FDAS).

1.02 **DESCRIBE** the operation of the Outside Underground Fire Protection Loop.

1.03 **DESCRIBE** the operation of the three major types of Fire Protection Systems used in CIF.

1.04 **STATE** which areas are associated with the first eight zones of the Main FACP.

1.05 **DESCRIBE** the operation of a Wet Pipe System, Dry Pipe System ,and Tank Farm Foam System valves and their associated alarms.

1.06 **DESCRIBE** the operation of the Fire Detection and Alarm components used within the CIF including method of actuation and general location.

1.07 **DESCRIBE** the DCS operation as it relates to the Fire Protection/Fire Detection and Alarm System.

1.08 **DESCRIBE** the automatic actions initiated by the Fire Protection/Fire Detection and Alarm System including initiating events and their significance

1.09 **EXPLAIN** the normal operations of the Fire Protection/Fire Detection and Alarm System to include actions for spurious alarms.

2.01 **DESCRIBE** the requirements for Infrequent/Abnormal operations of the Fire Detection/Fire Suppression and Alarm System (FP/FDAS).

SYSTEM OVERVIEW

Safety

Follow safety practices as required in Manual 8Q, *Employee Safety Manual*.

Manual 2Q, *Fire Protection Program Manual*, and CIF-AP-3103, *CIF Fire Protection Plan,* contain requirements specific to implementation and administration of the Fire Protection Program at the CIF. This Study Guide is designed to incorporate some of the requirements of these documents, but is not intended to be all inclusive.

The Fire Protection/Fire Detection and Alarm System is designed as part of the CIF Fire Protection Program. This program is designed to prevent fires from starting, to detect fires quickly, and to suppress fires that do occur by extinguishing them or controlling them until further response arrives, thus limiting their damage. Any changes to system status must be carefully reviewed prior to implementation to ensure maximum system readiness.

If there are any questions about a system status change, contact your supervisor or the On-duty Fire Warden before proceeding. Additional information is available from the Fire Protection Coordinator and the Fire Protection Program Department lead fire protection engineer for Solid Waste & Environment Restoration Division.

The water available for Fire Protection is to be used for Fire Protection only. Any temporary system or temporary connection to the Fire Protection system reduces the overall integrity of the system, and an alternate source should be used if a temporary supply of water is needed.

Fire Shutter

The firewall between the Box Handling Area and the ICR is penetrated by a window. To provide for firewall integrity an automatic fire door is installed above the window. This door rolls down from above the window with sufficient force to cause personnel injury. To assist with safety, a photoelectric detector is installed before the window. If the light beam from the detector is interrupted the signal to close is interrupted, and the door will not close. The arrangement of the detector will not prevent injury in all cases if someone is standing at the window. Care must be taken to avoid injury in the event of a fire automatically actuating the door.

Unusual Hazards

On-shift personnel have duties assigned to them in accordance with the *CIF Fire Protection Plan.* One duty that applies to all personnel is member of the Fire Response Team. The Shift Supervisor will designate personnel to assist the SRS Fire Department in response to emergency situations in order to offer information in their respective areas of expertise. In addition to knowledge of their assigned areas, personnel should be aware of the following hazards at CIF:

Location	Hazard
Entire Facility	High Voltage
Transformer east of 261-H	High Voltage
Throughout 261-H	RCA-Large portion of the facility
Ashcrete Room	Highest potential for airborne contamination
Tank Farm	Flammable and combustible liquids
North of Ram Feed Room	Pressurized cylinders
South of Ashcrete Room	3000 gal capacity vessel with air @ 135 psig
North of Tank Farm	500 gal Liquid Propane Tank
Southeast of 261-H	Two (2) 330 gal diesel fuel tanks
Offgas Area	Sodium Hydroxide

Table 1 Unusual Hazards for Fire Fighting at CIF

Introduction

The water used to fight a fire is supplied by a the Fire Protection Water System. This enables the firefighters to have a continuous supply of water designated for the purpose of fire suppression. It is supplied to the facility from H Area from the 12-inch fire water main connecting H Area and S Area. This supply runs underground in a loop around the facility. The piping in the North part of the loop is 12-inch, and the south part of the loop is 8-inch. An alternative supply is available from S Area, but is normally closed.

The detection of a fire and the actuation of the necessary alarms is accomplished through the Fire Detection and Alarm System (FDAS). This part of the system uses strategically located water flow switches, smoke detectors, heat detectors, ultraviolet/infrared detectors, and manual pull stations to detect fires and to alert CIF personnel and the SRS Fire Department of a fire in the CIF. Fire detection warning is provided by an Automatic Occupant Notification System connected to the FDAS in each building or area.

SYSTEM PURPOSE

ELO 1.01	**STATE the purpose of the Fire Protection/Fire Detection and Alarm System (FP/FDAS).**

Fire Protection

The Fire Protection (FP) System provides an active method to detect and extinguish a fire in the CIF using water as an extinguishing agent. The Fire Protection Systems receive water from an outside underground fire protection loop header. This header supplies "Fire Protection" water to five (5) fire hydrants located around the facility, two (2) of which are "monitor" hydrants (for foam making) near the Tank Farm.

The fire protection underground loop provides water to a Wet Pipe Sprinkler System, three (3) Dry Pipe Sprinkler Systems, and the Foam Deluge System in the Tank Farm. These systems utilize water as a suppression agent in the event of a fire in the facility. These systems operate automatically as long as a sufficient supply of water is available.

Additionally, the fire water can be used as an emergency backup supply for the Quench Vessel. This supply is controlled by a normally closed, air operated valve (H-261-SW-FV-4005), located near the Quench Vessel.

The Fire Protection System also provides two (2) manual fire hose outlets in the Box Handling Area. A permanently locked closed valve taps off of the north hose outlet line and leads to the ram feed housing emergency water curtain. This emergency water can be used to protect the ram feed housing from Rotary Kiln (RK) temperatures and conditions in the event that the RK fire door were to become stuck open.

Fire Detection and Alarm

The Fire Detection and Alarm System (FDAS) provides a means to detect a fire, provide local and ICR alarms, and automatically notify the SRS Fire Department of the alarm conditions. It also provides manual pull stations to initiate a fire alarm if a fire is seen in the facility. The FDAS also provides for detection and actuation of the Tank Farm Foam Deluge System.

Actuation of the Tank Farm Foam Deluge System is automatically initiated by Ultra Violet/Infrared (UV/IR) fire detectors sensing a fire in the Tank Farm from the Foam House Fire Alarm Control Panel (FACP). The Tank Farm Foam Deluge System can be actuated manually using a manual pull station located in the Foam House, or by pulling any of the four (4) pull stations located at the Tank Farm (following DCF).

All of the sprinkler systems are automatic in operation. They are provided with water flow detection to provide a signal to the FDAS and the facility. Hardwired and DCS interlocks are also provided to initiate process system shutdown, as required, in the event of a fire.

DESCRIPTION AND FLOWPATH

Fire Protection

Fire Protection consists of four (4) major systems: Outside Underground Fire Protection Loop Piping, Wet Pipe Sprinkler System, Dry Pipe Sprinkler Systems, and the Tank Farm Foam Deluge System. In addition to the major systems, nitrogen snuffing is available for manual initiation in the event of a fire in the ram feeder to the Rotary Kiln. A normally locked closed supply is available for the ram feed housing water curtain as a last resort in the event of a stuck open RK fire door.

ELO 1.02	**DESCRIBE the operation of the Outside Underground Fire Protection Loop.**.

Outside Underground Loop Piping

The normal water supply for the CIF Fire Protection System is provided by an underground 12-inch fire water main which taps off of the line connecting H Area and S Area, which runs west to east just north of the facility. The alternate supply is a twelve-inch line from S Area, and connects to the system via a normally closed gate valve at the northeast corner of the facility. Fire water is supplied by two (2) underground main lines and is routed through CIF by a twelve inch line running along the north side of the facility, and an eight-inch main to the south The two main lines form a loop around the facility and provide redundancy to ensure delivery of fire water in the event of a line failure. (See Figure 1, *Outside Underground (OSUG) Fire Protection Loop*.)

The OSUG Fire Protection Loop is controlled and operated by the Site Utility Department. All valve manipulations, except for emergencies will be performed by the Site Utility Department. During emergencies, the SRS Fire Department may Perform valve operations as required to support emergency response.

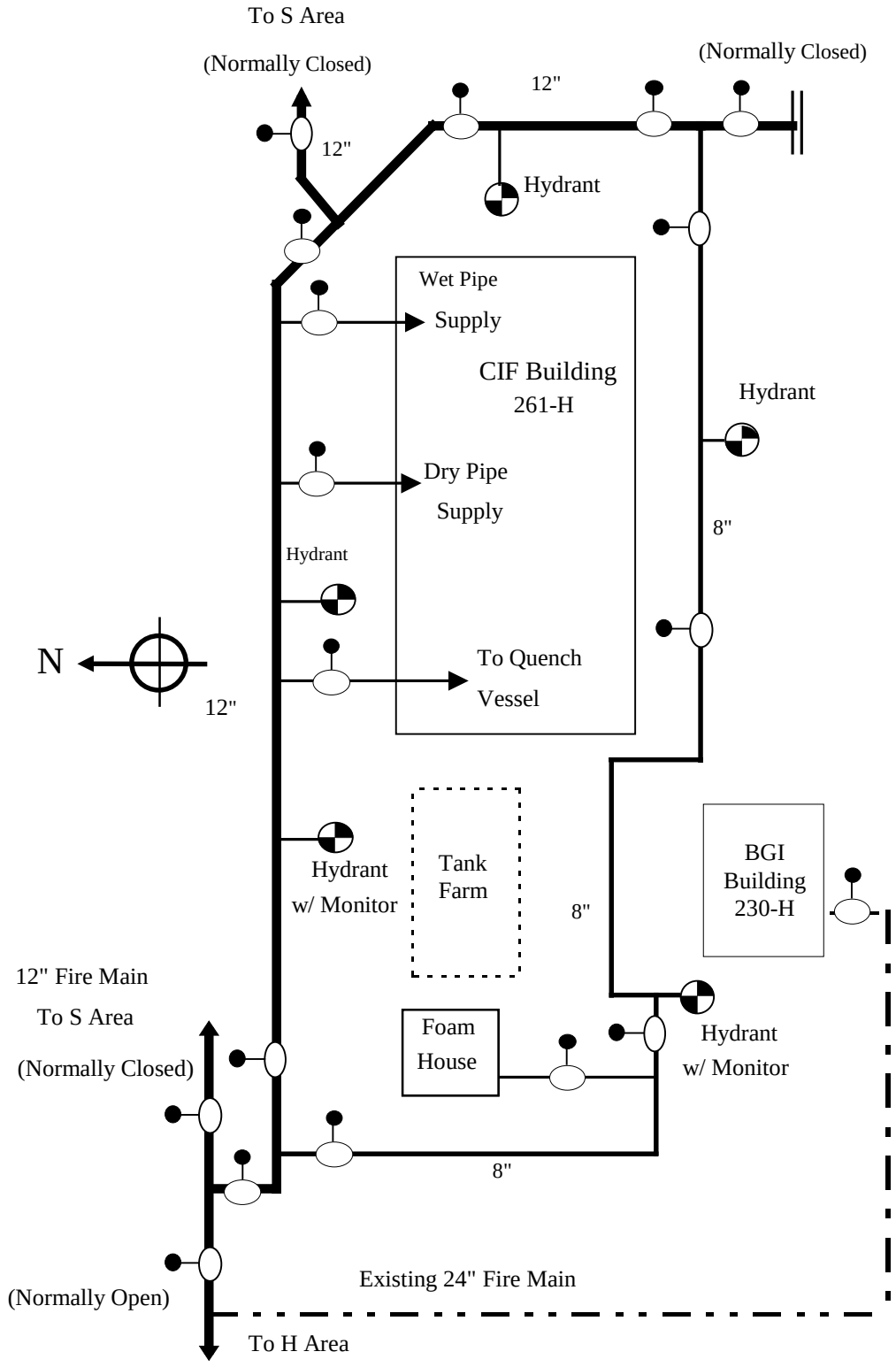

Figure 1 Outside Underground (OSUG) Fire Protection Loop

ELO 1.03 DESCRIBE the operation of the three major types of Fire Protection Systems used in CIF.

Wet Pipe Sprinkler System

The Wet Pipe Sprinkler System has supply water header pressure normally at 95-150 psig and is automatically actuated. The Outside Underground Fire Protection Loop supplies the Wet Pipe System. One line runs directly from the loop and two (2) lines are cross-connected to the Dry Pipe Sprinkler System. Two (2) of the three (3) lines provide pressurized water to alarm check valves V-700 and V-800. From the alarm check valves, the lines combine to a common header which leads to sprinkler system piping in the heated areas of the CIF. This main header splits into two lines, one leads to the Ram Feed Area, and the other to the Box Handling Area (including the loading dock and reject rooms), and the Control Room Building.

The third line provides water to the 1 1/2" hose connections in the Box Handling Area. One hose connection is located at the north end and the other at the south end of the Box Handling Area. (See Figure 2, *Wet Pipe Sprinkler System*.)

In the event of a fire, the heat will melt the fusible link on one (or more) sprinkler head, discharging water in the area of the fire. This drops the sprinkler header pressure and causes the alarm check valve to open. This pressurizes a pressure switch tied to the FDAS and actuates the alarm in the Control Room.

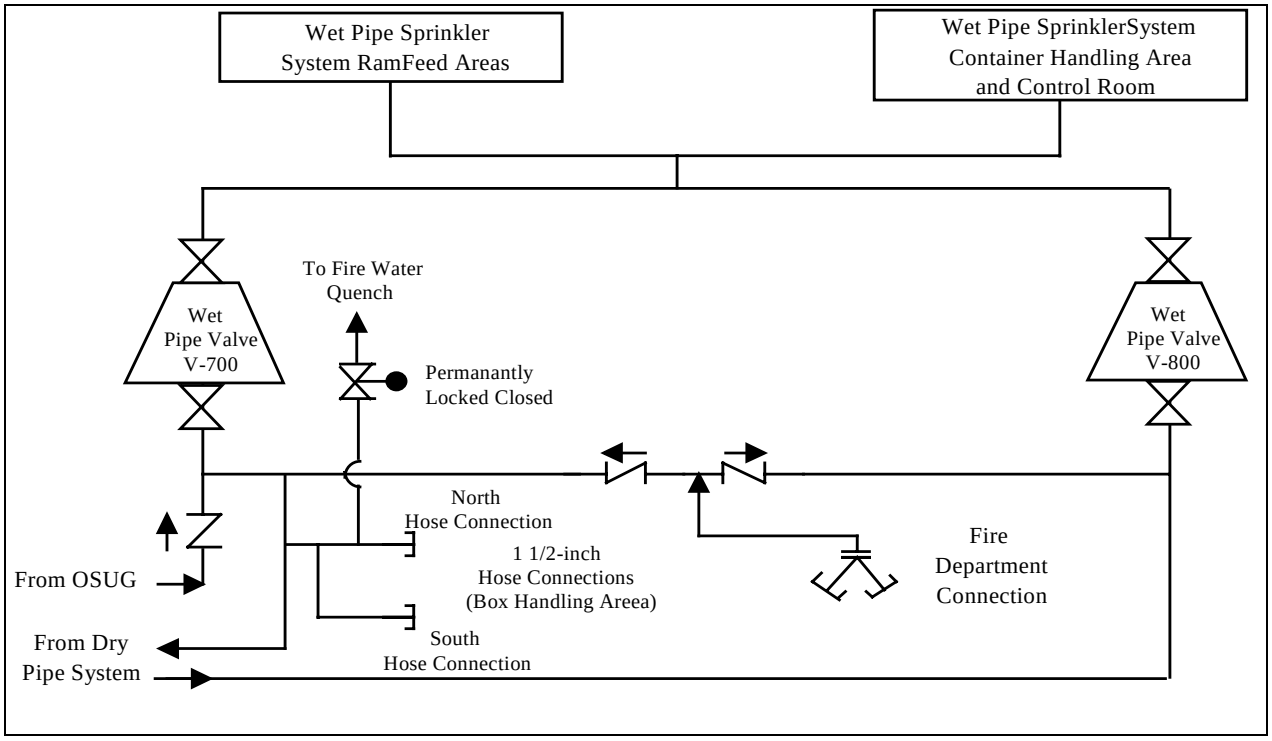

Figure 2 Wet Pipe Sprinkler System

Dry Pipe Sprinkler System

The Dry Pipe Sprinkler System has supply water header pressure normally at 95-150 psig, air header pressure at 35 to 45 psig, and it is automatically actuated. There are three (3) Dry Pipe Sprinkler Systems for fire suppression in the unheated process areas of the CIF. These areas are: Offgas process tank area, SCC/Quench and Ashcrete, and below the unheated roof areas of Building 261-H. Each dry pipe protected area is supplied by two (2) dry pipe valves with redundant risers.

As with the wet pipe system, if a fire generates enough heat to melt a sprinkler head fusible link, the sprinkler head would open. This releases the air pressure in the affected system, and allows air pressure to decay above the valve clapper. Fire header water pressure is sufficient to open the valve allowing water to fill the sprinkler piping and to discharge from any open sprinklers in the area of the fire. The dry pipe valves are equipped with accelerators which aid the water pressure in opening the dry pipe valves.

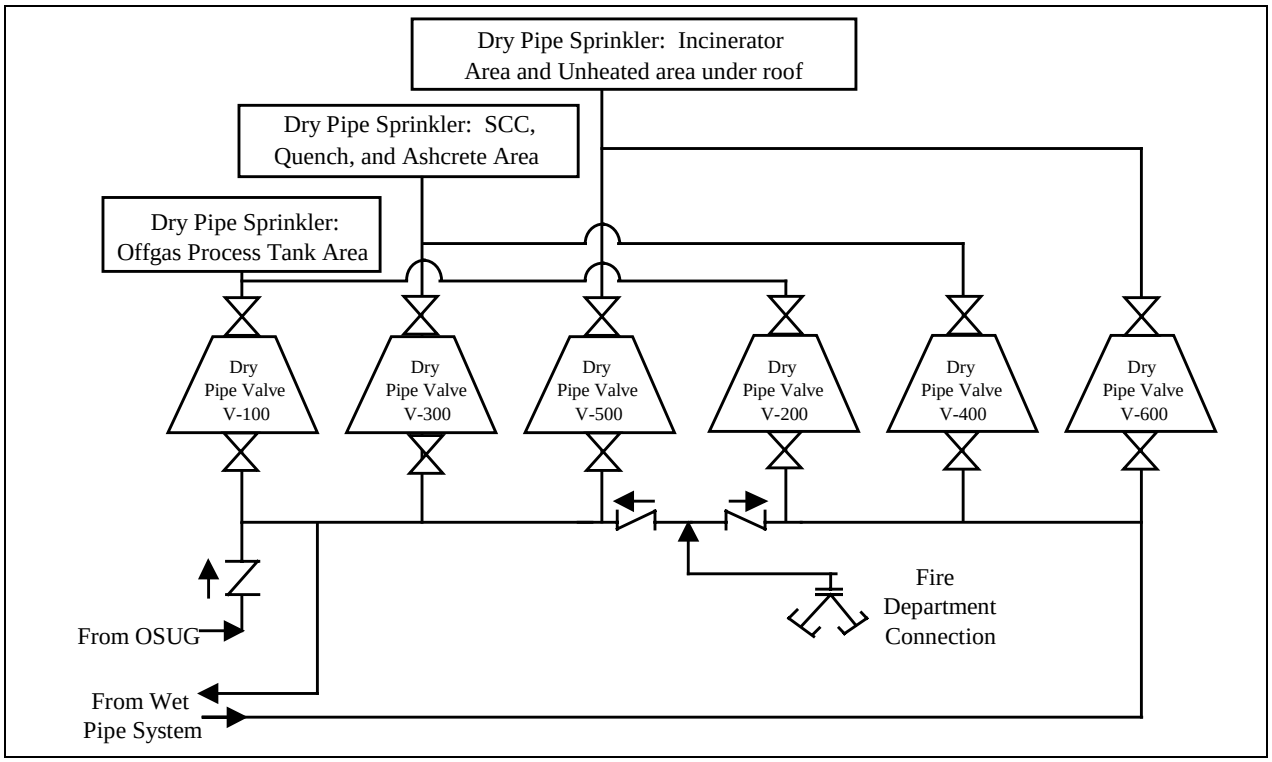

Figure 3 Dry Pipe Sprinkler System

Tank Farm Foam System

The tank farm diked area of the CIF is provided with an Aqueous Film Forming Foam (AFFF) Fire Suppression System. The Tank Farm Foam System can be actuated automatically or manually by using the pull station located in the southeast corner of the Foam House.

The Tank Farm Foam System introduces fire main pressure to the upstream side of a deluge valve located in the Foam House. Fire main pressure is also applied to the diaphragm actuator of the of deluge valve, which latches the clapper of the valve closed. When a fire is detected at the Tank Farm, a solenoid-operated valve opens to release water pressure from the diaphragm actuator. The latch releases the clapper and the valve opens to allow water to flow to the foam proportioner. Water pressure also actuates an alarm in the FDAS, flows to the foam tank to pressurize the outside of the bladder, and actuates a pneumatically operated valve. The pneumatic valve (FV-7001) controls the flow rate of the concentrated liquid foam to the flow proprtioner, where it is mixed with water at a 3 % foam concentration. The water and foam mixture then flows to the foam makers on the tank farm ring header.

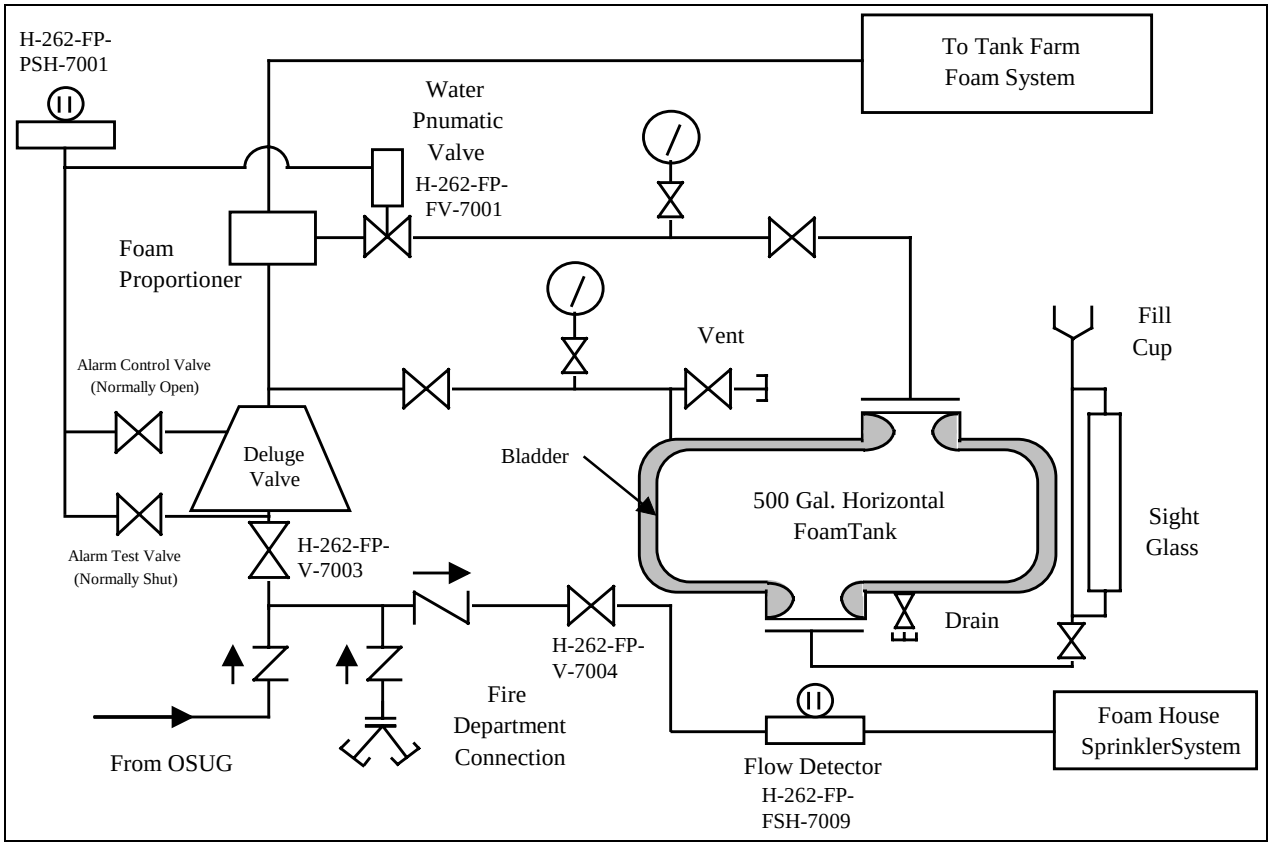

Figure 4 Tank Farm Foam System

The foam solution tank and the deluge valve are located in the Foam House, a metal walled building approximately 50 feet west of the diked area. Nine (9) foam makers (nozzles) are located on a ring header around the diked area wall, and discharge into the diked area. The designed water flow is 488 gpm with a 3 % concentration solution that will last approximately 30 minutes with 500 gallons of foam concentrate available.

The Foam House is equipped with a Fire Department connection so that the SRS Fire Department can provide an alternate source of water.

Nitrogen Snuffing

The ram feed chamber for the CIF is provided with a flame scanner (H-261-SWF-BAH-6256) to detect a fire in the ram feed housing. Upon notification of a flame scanner alarm at the DCS control panel, a solenoid valve may be actuated locally at the Ram Feed Control Panel, or remotely by DCS. Nitrogen is released into the ram feed chamber for five seconds. Six (6) nitrogen cylinders (two stations of three cylinders each) are supplied and are piped to a common connection at the solid feed chamber. Only two nitrogen cylinders for each header, for a total of four nitrogen cylinders, are required to be connected for system operation. All six nitrogen cylinders may be connected if available.

Water Quench Spray

The ram feed chamber for the CIF is provided with a temperature sensor (H-261-TAH-6265) to detect excessive heat in the ram feed housing. Upon notification of a high temperature alarm at the DCS Control Panel, a solenoid valve may be actuated locally at the Ram Feed Control Panel, or remotely through DCS. Water would be released into the ram feed chamber through spray nozzles until the temperature fell to the set point or the solenoid valve is manually closed. The water for this Spray is supplied from the Wet Pipe Sprinkler System hose connection at the north end of the Box Handling Area. The isolation valve which supplies this system is permanently locked closed to prevent inadvertent actuation which could result in wetting the RK refractory. This system would be used only in an emergency with prior approval of management.

Offgas Quench Vessel Emergency Supply

The Outside Underground Fire Protection Loop also supplies an emergency water supply to the Quench Vessel.

Fire Walls and Fire Shutter

The south wall of the Box Handling Area separating it the from the ICR, IER, and EER is a 2-hour rated fire wall. The window which penetrates this wall to view the Box Handling Area from the ICR is provided with a Fire Shutter which automatically closes upon fire detection in either area, and completes the boundary. The wall between the IER and the EER is also rated at two (2) hours.

Fire Detection and Alarm System

Fire alarms are generated by several types of detectors located throughout the CIF. Signals generated from the Tank Farm are sent to the Foam House Fire Alarm Control Panel. These signals are processed and sent as a single signal to the Main Fire Alarm Control Panel in the ICR. The Main Fire Alarm Control Panel also receives and processes all signals from remaining detectors throughout the facility. Signals to both panels actuate relays which complete circuits to the Critical Annunciator Panel and MCC 6 PLC (for DCS Alarms). The Main FACP also sends signals to the Box Handling Conveyor Control Panel in the Box Handling Area and the Autoterm in the ICR. The Autoterm generates the signal (via telephone line) to the Fire Alarm Computer System located in 709-F, to the Central Alarm Station, and to 221-H Canyon Control Room. (See Figure 5, *Fire Alarm Flow Path.*)

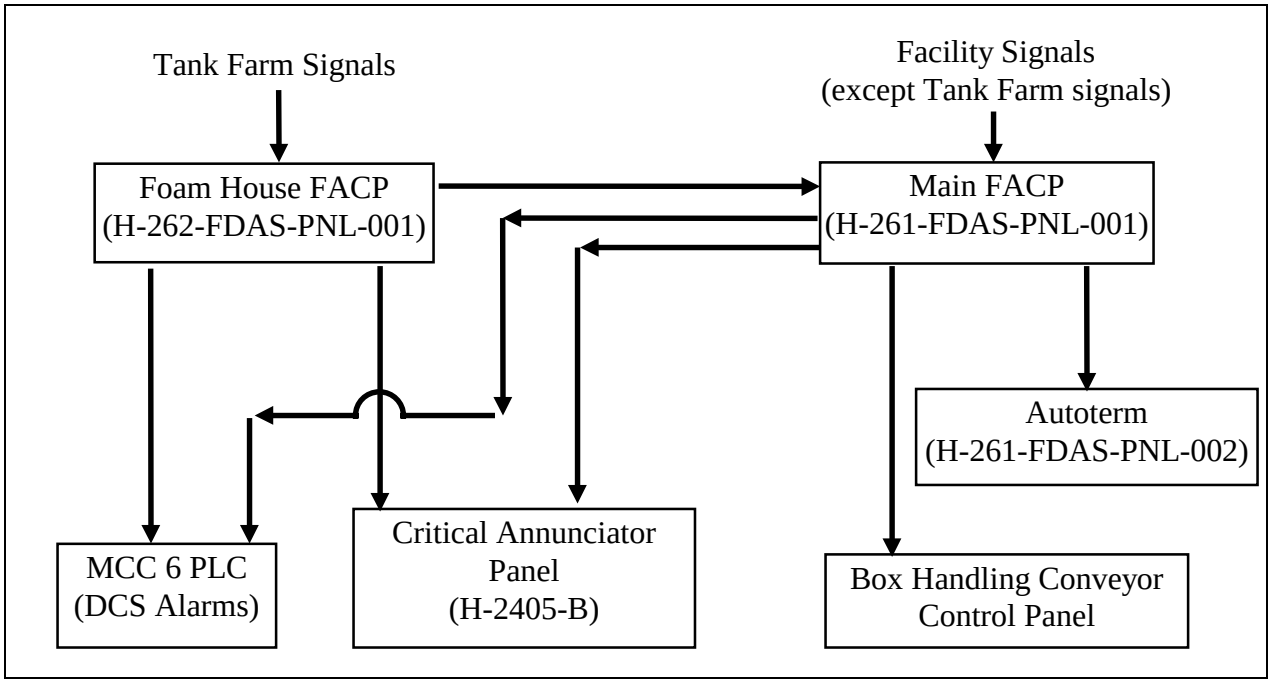

Figure 5 Fire Alarm Flow Path

ELO 1.04	**STATE which areas are associated with the first eight zones of the Main FACP.**

Fire Alarm Areas

Fire detection signals are generated and sent to the Main Fire Alarm Control Panel from eight (8) distinct areas. These areas correspond to the first eight alarm initiating circuits (hereafter called zones) in the Main FACP. The CIF is divided into these eight (8) areas, as follows:

1. Tank Farm (9 UV/IR detectors, 4 manual pull stations, 2 horn strobes, tamper switches)
2. Off Gas (3 manual pull stations, 3 horn strobes)
3. Incinerator/Ashcrete (19 manual pull stations, 9 horn strobes)
4. Box Handling (8 manual pull stations, 3 horn strobes, 11 photoelectric detectors)
5. ICR/IER (2 manual pull stations, 2 horn strobes, 4 photoelectric detectors)
6. EER (3 manual pull stations, 1 horn strobe, 5 photoelectric detectors)
7. Diesel Generators (1 manual pull station, 1 horn strobe, 1 photoelectric detector for each Diesel Generator)
8. Switchgear (1 manual pull station, 1 horn strobe)

It should be noted that signals originating from the Tank Farm Area are not differentiated on the Main FACP, but only indicate a single alarm. Operators must access the Tank Farm FACP to determine the cause of the alarm on the Main FACP.

There are other zones on the Main FACP corresponding to actuation of sprinkler systems, tamper switches on isolation valves, and dry pipe air pressure.

Summary

The Fire Protection System consists of:

- The Outside Underground Fire Protection Loop.
- The Wet Sprinkler System.
- The Dry Sprinkler System.
- The Tank Farm Foam System.
- The Nitrogen Suppression System.
- The Fire Water Quench System
- Fire Walls

The Fire Detection and Alarm System consists of:

- The Main Fire Alarm Control Panel.
- The Foam House Fire Alarm Control Panel
- The Critical Annunciator Panel
- Associated detection devices arranged in eight (8) areas

MAJOR COMPONENTS

ELO 1.05	**DESCRIBE the operation of a Wet Pipe System, Dry Pipe System ,and Tank Farm Foam System valves and their associated alarms.**

Fire Protection (FP)

Wet Pipe System Valves

A redundant pair of valves, FP-V-700 and FP-V-800, supply the Wet Pipe System. These are 4-inch Automatic Sprinkler Model 353 alarm valves. They are located at the northeast corner of the container handling area.

The alarm check valve has a grooved seat ring with openings connected by trim piping to the retard chamber. When placed in service, water is allowed to fill the system until system pressure and supply pressure are equal. System pressure then causes the rubber-faced clapper of the alarm valve to close tightly on the grooved seat ring. The clapper stays closed as long as system pressure is equal to or greater than supply pressure. Surges in supply pressure are allowed to pass around the closed clapper through the external bypass or through the clapper itself, and become trapped above the clapper. System pressure will often be greater than supply pressure due to pressure surges being trapped above the clapper.

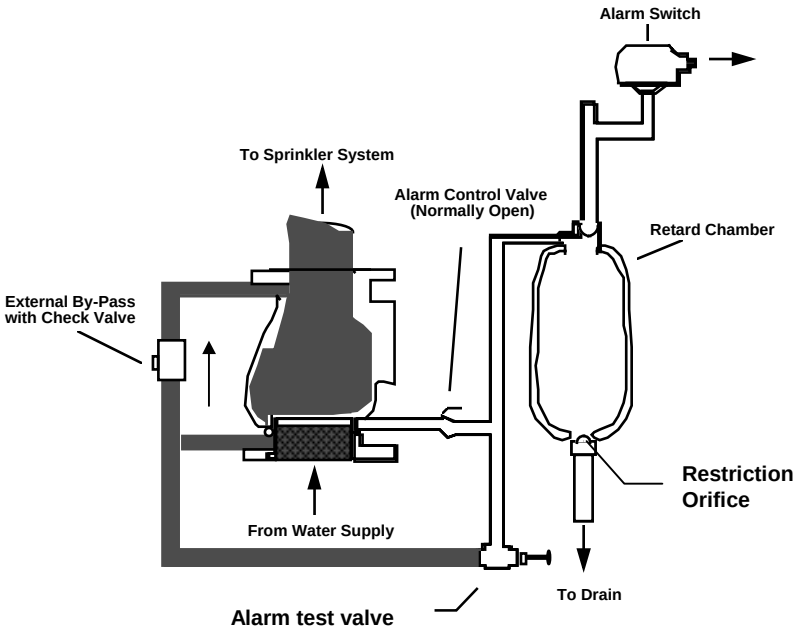

Figure 6 Wet Pipe System Valve Ready For Operation

When a sprinkler operates, water flow is sufficient to relieve system pressure. Supply pressure then opens the valve clapper to supply unobstructed water flow to the open sprinkler. At the same time, water flows through the seat ring openings to the retard chamber. The volume of the water entering the retard chamber is greater than that which can drain from the chamber due to a restriction orifice. The water fills the chamber, flows to the pressure alarm switch (PSH-7202 or 7205), and pressurizes it.(See Drawing W841440, *Wet Pipe System Piping*.)

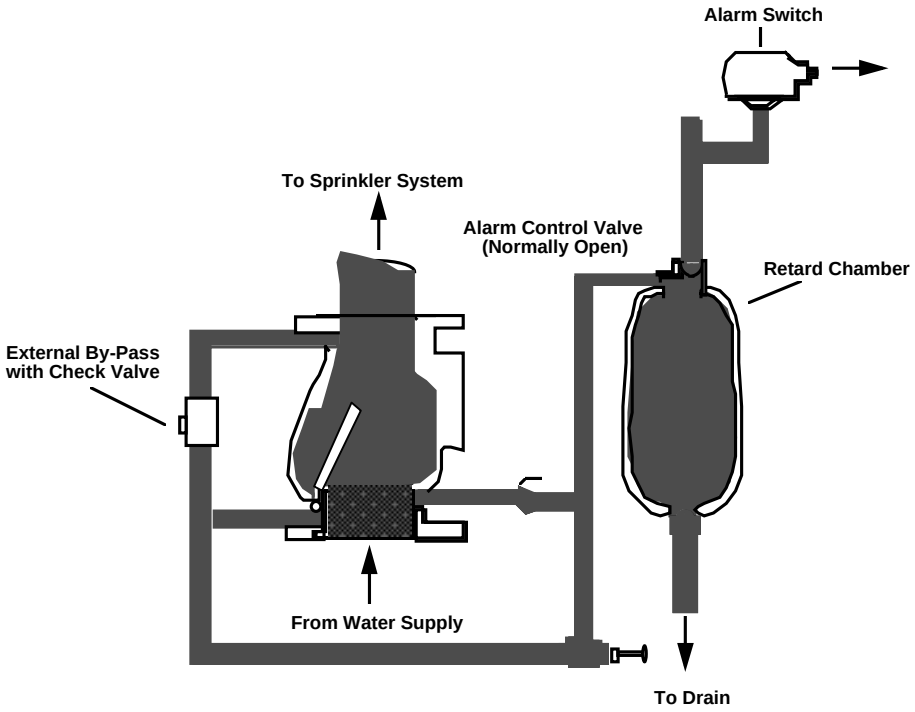

Figure 7 Wet Pipe System Valve During Operation

The Wet Pipe Sprinkler System valves have no internal latch and will re-close when water flow has stopped.

Dry Pipe System Valves

Six (6) actuation valves, FP-V-100, FP-V-200, FP-V-300, FP-V-400, FP-V-500, and FP-V-600, are provided for the Dry Pipe System. Each protected area is supplied by a redundant pair of valves. These are 6-inch Automatic Sprinkler Model 39A dry pipe valves, and are located inside the north wall of the Ram Feed/Kiln enclosure on the ground floor.

The dry pipe valves are a differential pressure type with an intermediate chamber. In the ready position a rubber faced clapper closes tightly on two concentric seat rings. The inner ring is the water seat and the outer ring is the air seat. The annular space between the rings is the intermediate chamber. With the valve in service (ready), the annular space is dry and open to atmosphere through the velocity check valve.

Priming water is maintained above the clapper to provide a positive seal to prevent air leakage from the Dry Pipe System through the intermediate chamber. Compressed air from 35 to 45 psig is maintained above the water level and throughout the dry pipe header.

This air and priming water pressure on the larger area above the clapper offsets the higher supply water pressure acting on the smaller area below the clapper (inner seat ring). The clapper is held closed as long as air pressure is maintained at least one sixth (1/6) of the water pressure.

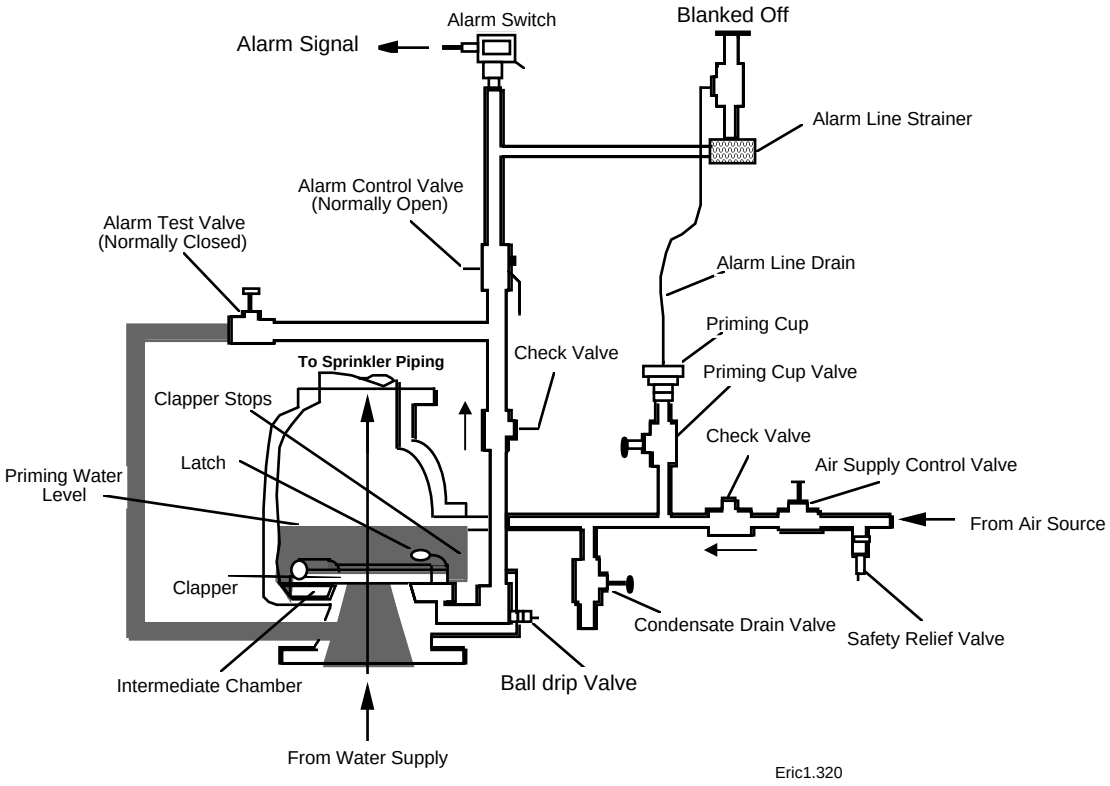

Figure 8 Dry Pipe System Valve Ready For Operation

When a sprinkler operates, air pressure is lost through the open sprinkler head faster than the air regulator can make it up. Supply water pressure then lifts the clapper, allowing water to flow into the system and to the open sprinkler. At the same time, water flows into the intermediate chamber, closes the velocity check valve, flows through the alarm line connection, and pressurizes the alarm pressure switch (See Drawings MM6H 4743, MM6H 4744, and MM6H 4745 for alarm details.)

Due to the size of the dry pipe headers, pressure loss in the header can take a long time, and would delay the opening of the dry pipe valve. To speed up the operation, an accelerator is provided as a quick opening device. It is a small accumulator which stores air against a spring-loaded diaphragm-operated outlet valve. The inlet to the accumulator is header air pressure. When a sprinkler opens, a small decrease in system air pressure allows the spring to open the accumulator outlet. This places remaining system air pressure directly in the intermediate chamber, under the clapper, where it assists supply water pressure in opening the clapper. Although accumulator air pressure is less than header pressure (due to throttling effects), the combined effect of the water pressure and the accumulator air pressure on the area under the clapper is sufficient to quickly open the valve.

The inlet to the accelerator is provided with an anti-flooding device to prevent water from entering the accumulator once water has filled the dry pipe header

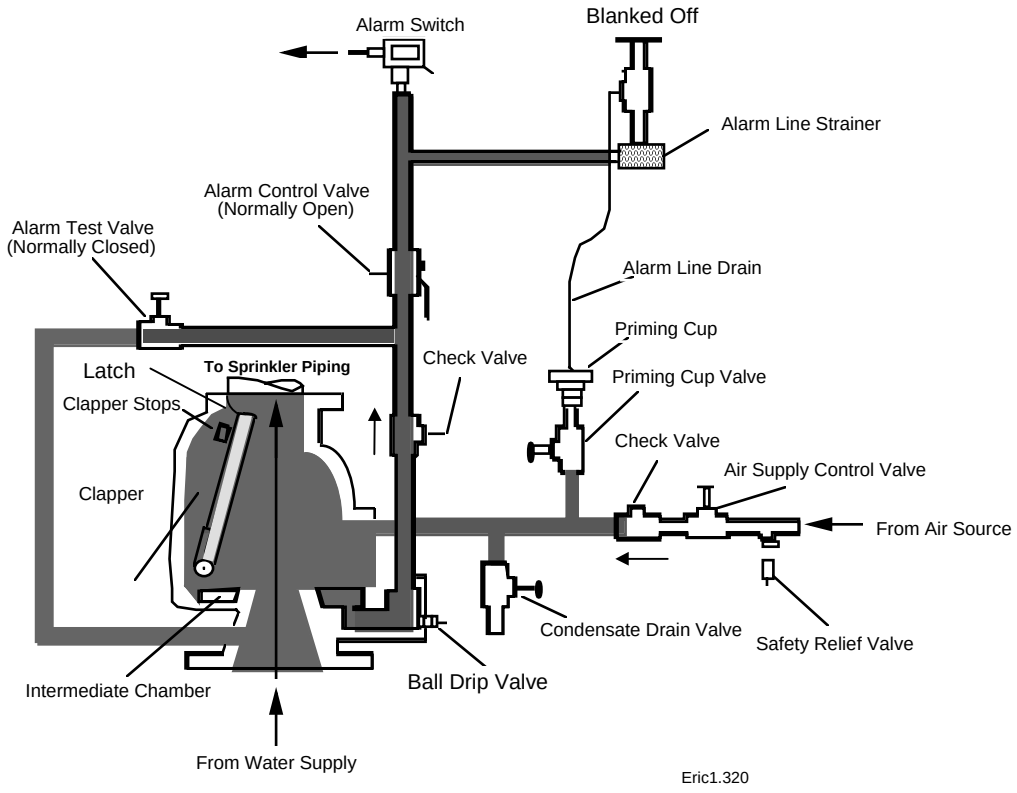

Figure 9 Dry Pipe System Deluge Valves During Operation

Following operation of a dry pipe valve, the valve will remain open on a latch. Following operation of any dry pipe sprinkler system, the valve body must be opened to release the clapper from the open position.

Tank Farm Foam System Deluge Valve

The Tank Farm Foam System has one deluge valve, H-262-FP-V-100. The valve is located in the southeast corner of the Foam House. This is a 4-inch Automatic Sprinkler Model F deluge valve. The deluge valve depends on the water pressure acting on a diaphragm actuator, which holds a latch in place and maintains the clapper closed against supply water pressure. Allowable supply water working pressure for the Model F deluge valve is 20 to 175 psig.

In the set position, the clapper is held closed by the latch. The latch is held in place by the upward pressure of the diaphragm actuator push rod. The actuator is supplied (via a restricting orifice) from main supply water at a point upstream of the deluge manual isolation valve (normally open). This supply is also connected to the manual release valve (normally closed) and the solenoid release valve (normally closed).

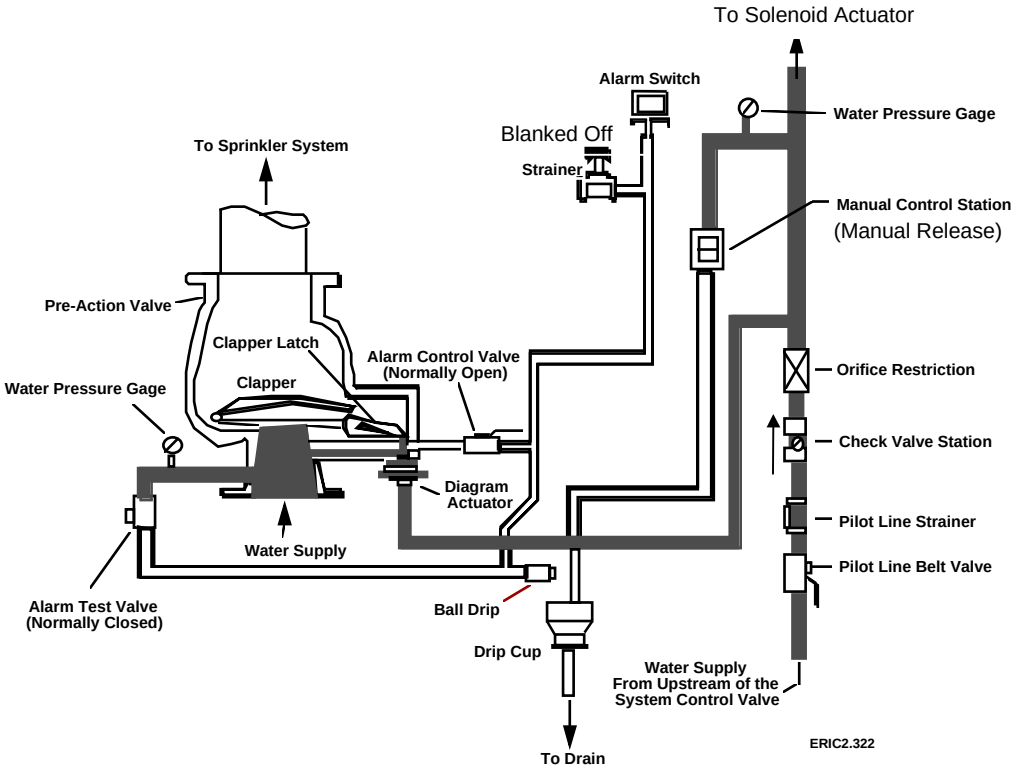

Figure 10 Tank Farm Foam System Deluge Valve Ready For Operation

When a tank farm fire is detected and confirmed by the Ultraviolet/Infrared detectors, the solenoid release valve is opened, and water pressure at the actuator is relieved. Water main pressure flows through the restricting orifice, but water is drained faster than can be made up. Without the force of the water to hold it in place, the actuator push rod lowers, releasing the latch. System supply water pressure forces the clapper open, allowing water to flow into the system. The Foam House FACP is being modified to actuate the solenoid valve when any pull station located at the Tank Farm is activated. Opening the manual

release valve in the Foam House also releases the pressure on the actuator diaphragm and operates the deluge valve in the same way.

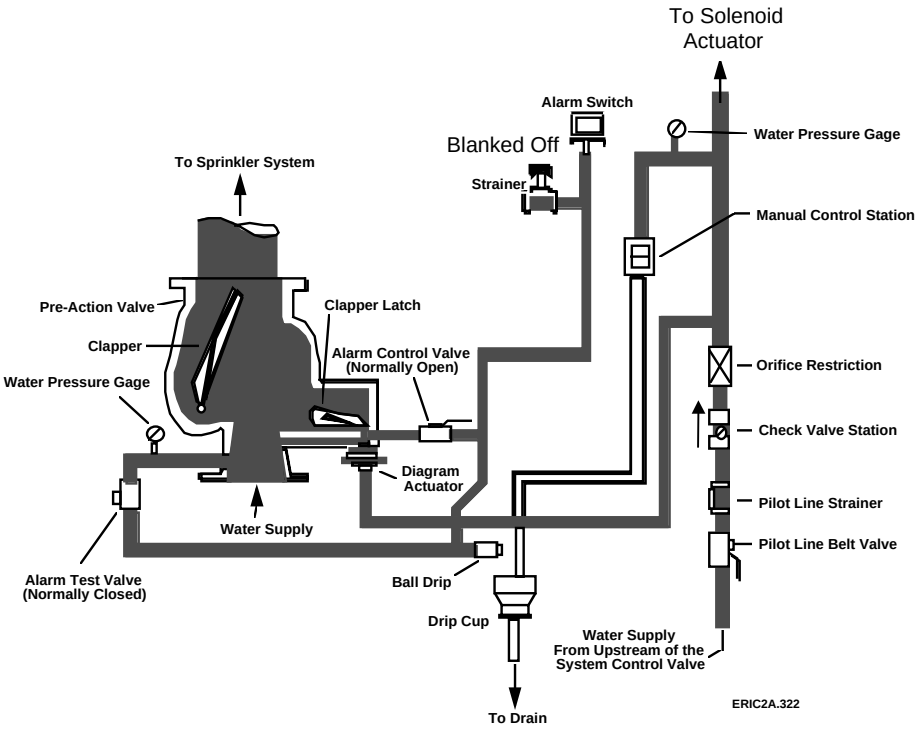

Figure 11 Tank Farm Foam System Deluge Valve During Operation

When the clapper latch is released, water flowing into the system also flows into the alarm sensing line. The flow closes the ball drip valve fills the line and pressurizes the alarm switch, which activates the alarm. There is an internal latch in the deluge valve which maintains the clapper open. Following operation of the foam system, the valve body must be opened to release the clapper from the open position.

Foam Concentrate Storage Tank

The Foam Concentrate Storage Tank is a horizontal 500-gallon capacity Ansul bladder tank with a working pressure of 175 psig. The foam concentrate is stored in an elastomeric bladder in the tank and is normally full. When the system is actuated, water flowing into the system also flows to the tank, where it fills the volume between the tank shell and the outside of the bladder. Concentrate is discharged from the tank by the water applying system pressure to the exterior surface of the bladder, which is smaller in area than the inside surface. This forces the foam to flow out of the bladder and through the proportioning valve (FV-7001) which supplies pressurized concentrate to the proportioner.

Fire Walls and Fire Shutter

The south wall of the Box Handling Area separating it the from the ICR, IER, and EER is a 2-hour rated fire wall. The window which penetrates this wall to view the Box Handling Area from the ICR is provided with a Fire Shutter which automatically closes upon fire detection in either area, and completes the boundary. The wall between the IER and the EER is also rated at two (2) hours.

Fire Detection and Alarm System (FDAS)

Two Fire Alarm Control Panels (FACP) and the Critical Annunciator Panel are provided which supply input to DCS and Rad/Fire Protection Alarm Panel alarms.

Critical Annunciator Panel

This panel (H-2405-B), located in the ICR, receives inputs from the Main FACP. The Main FACP contains relays which are actuated by alarming conditions in the FACP. The relays are directly wired to the Critical Annunciator with no interface with DCS.

It is a standard PANALARM annunciator with segmented windows for each alarm message (engraved on the window). An alarm condition is signaled by a horn and the associated window lighted (flashing). An acknowledge push-button is used to silence the horn and seal in (steady light) the alarm window segment (3 per window). This panel operates to notify operators of alarming conditions and is independent of DCS alarms. The ICR Operator must access the DCS to verify status of actuation of fire suppression components.

The Main FACP

This panel is located along the south wall of the ICR. It provides status for the Wet Pipe System and Dry Pipe System fire protection valve components. It receives inputs from the Foam House FACP and the FDAS components in Zones 2 through 8, and outputs to the Critical Annunciator Panel, the Box Handling Conveyor Control Panel, MCC 6 PLC (for DCS Alarms), and the Autoterm in the ICR. The Autoterm generates the signal (via telephone line) to the Fire Alarm Computer System in Building 709-F.

The main FACP is powered (120V AC) from Instrument Power Panel "A", (610-06). This circuit also supplies a 120-18V AC transformer (4957-660-32) which powers the Autoterm. Two (2) 12-volt batteries located in the bottom of the panel are wired in series for a 24-volt supply and are capable of providing 24 hours of backup monitoring and 5 minutes of alarm signals at the end of the 24 hour period. Two (2) storage batteries are also located in the panel and provide backup for the Autoterm.

The Main FACP contains a common control module, several series modules, an auxiliary relay module, and other control and signaling modules. The common control module provides the main interfaces for operators. LEDs and switches and acts as a motherboard for

system signals. The series modules are daughter boards which can accept multiple connections such as smoke detectors, pull stations, and other alarm or warning indication devices. The auxiliary relay module provides connection to and signaling through auxiliary relays.

Table 2, Common Control Module LEDs, contains the nomenclature and purpose of the LEDs on the common control module. Table 3, Common Control Module Switches, lists the nomenclature and function of the switches on the common control module.

LED	Color	Purpose
AC Power On	Green	120-volt supply is available
AC Power Off	Red	120-volt supply is not available
Alarm	Red	Indicates that a module is receiving a zone alarm signal
Trouble	Amber	Indicates that a module is receiving a zone trouble signal (i.e. open circuit)
City	Red	N/A
Earth	Amber	Indicates that a ground exists somewhere on the system
Batt Trouble	Amber	Indicates low battery voltage or no battery connected
Hi-Rate	Amber	Indicates battery is charging at a high rate
Plug-In	Amber	N/A

Table 2 Common Control Module LEDs

The Foam House FACP

This panel is located in the Foam House and provides status for Tank Farm UV/IR detectors, valve tamper switches, foam system actuation (pressure), and sprinkler actuation (flow). It receives inputs from the Tank Farm and Foam House only, and outputs to Zone 1 of the Main FACP in the ICR (alarm and trouble signal input) and the Critical Annunciator Panel, H-2405-B (ICR alarm input). It is powered (120V AC) from Instrument Power Panel D, (H263-610-11). Like the Main FACP, it has two(2) 12-volt batteries in series which provide a backup 24-volt supply which can provide 24 hours of monitoring and 5 minutes of alarming following the 24 hour period.

The internal components are similar to those in the Main FACP. The operation of the common control module is the same except that the Foam House FACP only interacts with the Autoterm panel via the Main FACP. Since the Foam House FACP receives and processes all the signals in the Tank Farm Area and sends a single signal to the Main FACP, silencing the Main FACP for Zone 1 of the Main FACP only acknowledges that undistinguished signal. An alarm on Zone 1 of the Main FACP must be investigated to the level of determining which zone of the Foam House FACP is causing the alarm. The alarm

relays in the Foam House FACP are separately wired to the Critical Annuncitor Panel and DCS.

Switch	Push-button/ Latch	Function
Alarm Acknowledge	Push-button	Silences the current alarm, but allows for subsequent alarms to be received
Drill	Latch	Allows for testing of the audible alarms and visual strobes without causing other alarm functions
Alarm Off	Latch	Silences alarms and secures strobes and cuts out signal to Fire Department
Hi-Rate	Latch	Forces the battery charger into a high-rate charge
Trouble	Latch	Silences alert for trouble conditions
Reset	Push-button	Returns system to normal after signals are no longer alarming
City	Latch	N/A
Lamp Test	Push-button	Tests all system LEDs to show possible failure

Table 3 Common Control Module Switches

Summary

The Fire Protection System major components include:

- The Wet Pipe System deluge valves
- The Dry Pipe System deluge valves
- The Tank Farm Foam System deluge valve
- The foam concentrate storage tank
- Fire Walls

The Fire Detection and Alarm System major components include:

- The Main Fire Alarm Control Panel
- The Foam House Fire Alarm Control Panel
- The Critical Annunciator Panel
- Associated detection devices arranged in eight (8) zones

INSTRUMENTATION

Fire Protection

Fire Protection Wet Pipe Pressure

Water pressure is measured by the use of pressure gauges on the supply and discharge of each alarm check valve.

On each alarm check valve there is a pressure switch that monitors water pressure. (See Figure 7 *Wet Pipe System Valve During Operation*.) With increasing water pressure the switch will actuate which will cause an alarm that is fed to the Fire Alarm Control Panel (FACP). This signal gives indication of sprinkler system actuation.

Fire Protection Wet Pipe Flow

There is a tamper switch located on the yoke of each alarm check valve inlet and outlet outside screw and yoke (OS&Y) isolation gate valve. If the OS&Y valve is started closed, the inward stem movement causes the switch contacts to close which sends an alarm to the associated FACP alarm module indicating that flow may be interrupted.

Fire Protection Dry Pipe Pressure

Water pressure is measured by the use of pressure gauges for each of six (6) dry pipe valves.

Each dry pipe valve has a water pressure switch. When this switch actuates, it provides the Main FACP within alarm indicating sprinkler system actuation. (See Figure 9, *Dry Pipe System Deluge Valves During Operation*.)

An air pressure switch monitors air pressure in the dry pipe headers. This alarms when the air pressure drops to 35 psig (decreasing) or raises to 45 psig (increasing). This indicates an air system trouble condition.

Fire Protection Dry Pipe Flow

The tamper switch locations and operation for the Dry Pipe System is the same as the Wet Pipe System.

Fire Protection Foam System Pressure

Water pressure to the deluge valve is measured by two (2) 0-250 psig water pressure gauges: one is on the supply trim to the deluge valve, and other is in the trim supply to the latching diaphragm. Two (2) 0-250 psig gauges are provided to monitor system pressure in the lines downstream of the deluge valve; one in the water supply to the Foam Tank and other in the

foam concentrate outlet line. (Refer to Drawing W835623, *Tank Farm Foam System* for further detail.)

There is a pressure switch located on the valve trim piping which provides local (Foam House FACP) and ICR (Main FACP) alarms on increasing pressure and indicates system actuation. (See Figure 11, *Tank Farm Foam System Deluge Valve During Operation*.)

Fire Protection Foam System Flow

The tamper switch operation of the Foam System is the same as for the Wet Pipe System. There are two (2) tamper switches located in the foam house; one is provided for the deluge valve inlet Outside Screw and Yoke (OS&Y) gate valve and other is for the Foam House sprinkler header isolation OS&Y gate valve. (See Figure 4, *Tank Farm Foam System*.)

A paddle-type flow switch is located in the water supply to the foam house sprinkler header. When flow is sensed, the paddle is deflected causing switch actuation to occur. The contacts of the switch close and supply current to the Foam House FACP modules and indicates system actuation.(See Figure 4, *Tank Farm Foam System*.)

Fire Detection and Alarm System

Fire Alarm Control Panel

ELO 1.06	**DESCRIBE the operation of the Fire Detection and Alarm components used within the CIF including method of actuation and general location.**

Each alarm module is provided with red LEDs for field alarm conditions and amber LEDs for trouble or fault conditions. These modules are divided into zones. The areas designated by the Main FACP zones 1 to 8 are commonly referred to zones 1 to 8 for convenience, but the Foam House FACP is also divided into zones. The Fire Detection and Alarm System is provided to monitor plant areas and fire protection equipment, and alert plant and SRS Fire Department personnel in the event of a fire or abnormal system condition. The Fire Detection and Alarm System contains the following components:

Horn/Strobe Alarm Stations
Activated by any alarm
Automatic when detector activates
Alarm until alarm module reset
Strategically located throughout the facility

Pull Boxes
Manually actuated
Operated by pulling "PULL" switch forward for normal boxes
Open door then depress lever for explosive-proof boxes
lever held in alarm position until reset using key
Strategically located throughout the facility

Heat Detectors for the CONVEYOR EQUIPMENT
Automatic when set Temperature exceeded
Melting insulation provides continuity for wire pair strung above conveyors

Ultraviolet/Infrared (flame) Detectors for the TANK FARM
Automatically activated by presence of light energy from fire
Responds to light energy emitted by the burning of CO_2 and H_2 typical of hydrocarbon fires
May respond to welding light (it is designed not to)
May respond to sunlight (it is designed not to)

Photoelectric(smoke) Detectors
Operates on the light scattering principle
Smoke enters detection chamber
Light scattered by smoke particles
Uses an infrared light source
Signal is sent to control panel
Located in the Box Handling Area, Control Building and diesel generator buildings
Detectors also contain thermal element which responds to temperatures above $135^{o}F$

Critical Annunciator Panel Alarms

The Critical Annunciator Panel (H-2405-B), located in the ICR, receives inputs from the Foam House FACP and the main FACP (alarm module contact closure, hardwired to H-2405-B). These alarm signals are independent of DCS.

The alarms provided are for Fire Protection valve status, including:

- Isolation and Maintenance valve closed (tamper switches) for each valve
- High pressure (valve actuated) for each automatic sprinkler valve (Wet, Dry, or Deluge)
- Off-Gas, SCC and Quench, and Incinerator (Dry Pipe) Supervisory Air Pressure High or Low
- Foam House sprinkler flow

Autoterm

The Autoterm panel is provided with digital indication of the signals generated and sent to the Fire Alarm Computer System, the Central Alarm Station, and 221-H Canyon Control Room. The indication is a two (2) digit LED code which corresponds to signal groups as listed in Table 4, *Autoterm Indications.*

Digital Display	Indication
01	AC Power Loss
02	Tamper (Panel cover)
03	Tank Farm Alarm
04	Offgas Alarm
05	Incinerator/Ashcrete Alarm
06	Box Handling Alarm
07	Control Room Alarm
08	Diesel Generator and Switchgear Alarm
09	Common Trouble
10	Offgas Sprinkler Flow
11	SCC & Quench Sprinkler Flow
12	Incinerator Sprinkler Flow
13	Box Handling Sprinkler Flow
14	Tank Farm Foam System Flow
15	Dry Pipe Air Hi/Lo
16	Valve Tamper
91	CPU Malfunction
92	Loss of Interrogation Signal
93	Communication Failure

Table 4 Autoterm Indications

Summary

- The Fire Protection System contains valve position, pressure and flow instruments which indicate system status.
- The Fire Detection and Alarm System receives and processes these signals as well as the indications available from dedicated detectors.
- Detectors used include automatic photoelectric (smoke), ultraviolet/infrared, and heat detectors as well as manual pull stations.

CONTROLS, INTERLOCKS AND ALARMS

Controls

Component status, process values and control functions are identified using DCS Point Tag Displays. Operation of the Fire Protection/Fire Detection and Alarm System is automatic utilizing fusible links to initiate spray flow in the Wet and Dry Pipe Systems, and solenoid-activated valves to initiate the Tank Farm Foam System.

ELO 1.07	**DESCRIBE the DCS operation as it relates to the Fire Protection/Fire Detection and Alarm System.**

DCS repeats alarm operation for the Fire Detection and Alarm System when the proper plant conditions exist. Additionally, DCS provides component status, component process values, and component control functions. DCS also permits the operator to verify status of actuation of fire suppression components.

DCS provides the control for interlocks for systems outside of the FP/FDAS with the exception of the box handling conveyors

There is a DCF to modify the Foam House FACP so that actuating any of the four (4) pull stations located at the Tank Farm will activate the Foam System solenoid. Upon completion of this DCF, pulling any of these four pull stations will initiate the Foam System.

Interlocks

Detection of a fire in the Box Handling, ICR, IER, EER, and Ram Feed Area will cause the shutdown of certain systems and/or components (See Table 5, *Automatic Actions*). Shutdown is hardwired (Box Handling system) from the main FACP, or via the DCS (PLC 6) from the main FACP.

The Foam House FACP receives UV/IR signals from the detectors located at the Tank Farm. These nine (9) signals are grouped into two (2) circuits; one circuit from four of the detectors, and the other from the remaining five detectors. These circuits are arranged so that any two detectors which monitor the Tank Farm from the same direction are on different circuits. A signal from each circuit is required to automatically initiate the Foam System. This arrangement is necessary to prevent an inadvertent signal which is generated in a single direction (such as reflected sunlight off a tag) does not initiate an unwanted Foam System actuation.

ELO 1.08 DESCRIBE the automatic actions initiated by the Fire Protection/Fire Detection and Alarm System.

Action	Box Handling Fire	Ram Feed Room Fire	ICR Fire	IER Fire	EER Fire
Conveyors Shutdown	X	X	X	X	X
HVAC Supply Air Stop	X	X			
Control Room Ventilation Stop			X	X	
Incinerator Shutdown					
RK Solid Feed Stop		X	X	X	X
RK Liquid Feed Stop		X	X	X	X
RK Fuel Oil Stop		X	X	X	X
SCC Waste Feed Stop		X	X	X	X
SCC Fuel Oil Stop		X	X	X	X
Combustion Fans					
RK Fuel Oil Fan Stop			X	X	X
RK Solids Fan Stop			X	X	X
RK Waste Burner Fan Stop			X	X	X
Tertiary Fan Stop			X	X	X
SCC Fuel Oil Fan Stop			X	X	X
SCC Waste Burner Fan Stop		X	X	X	X

Table 5 Automatic Actions

Alarms

The Fire Protection/Fire Detection and Alarm System has the following associated alarms:

Alarm	Setpoint	Units
Low Air Pressure Offgas PAL-1009	35	PSIG
High Air Pressure Offgas PAH-1009	45	PSIG
Isolation Valve Closed Offgas ZS-1011(A),(B)	Not Open	N/A
Low Air Pressure SCC PAL-1104	35	PSIG
High Air Pressure SCC PAH-1104	45	PSIG
Isolation Valve Closed SCC ZS-1110 (A),(B)	Not Open	N/A
Low Air Pressure Incinerator PAL-1206	35	PSIG
High Air Pressure Incinerator PAH-1206	45	PSIG
Isolation Valve Closed Incinerator ZS-1210 (A),(B)	Not Open	N/A
Low Nitrogen Supply Pressure PSL 2104	350	PSIG
Low Nitrogen Snuffing Pressure PSL-2105	5	PSIG
Isolation Valve Closed Tank Farm Deluge ZS-7003	Not Open	N/A
Isolation Valve Closed Foam House Sprinkler ZS-7004	Not Open	N/A
Isolation Valve Closed Wet Pipe ZS-7208 (A),(B)	Not Open	N/A
Isolation Valve Closed Wet Pipe ZS-7209 (A),(B)	Not Open	N/A

Table 6 Alarm Setpoints

SYSTEM INTERRELATIONS

Nitrogen System

Bottled nitrogen provides a supply of inert gas for fire suppression (Nitrogen Snuffing) at the ram feeder for the Rotary Kiln (RK). Six (6) nitrogen bottles are supplied and piped into a common header at the ram and solid feed chamber. In addition to the Nitrogen Snuffing System, the ram feed has a wet pipe fire protection back-up (fire water quench spray).

DCS

FP/FDAS interacts with DCS for alarm functions and controls not hardwired. A signal for a fire detected in the Incinerator/Ashcrete Area, ICR/IER, and EER (Zone 3, 5 or 6) is hardwired to MCC-6 PLC. Any of these signals then cause loss of the Incinerator Permissive B relay. Loss of the Incinerator Permissive B relay causes loss of the Burner Management System (BMS) permissive relay. When the BMS permissive relay is lost, the Incinerator will shut down due to hardwired relays which secure fuel flow.

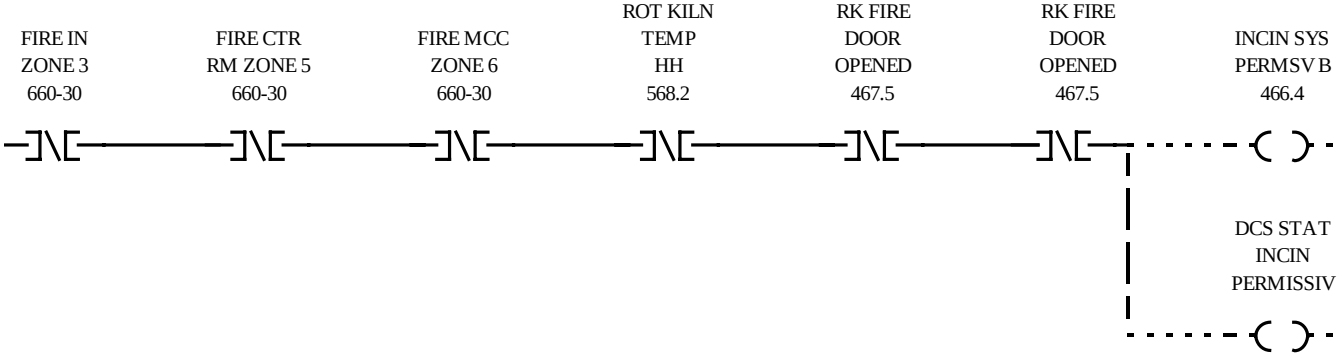

Figure 12 Incinerator System Permissive B Relay

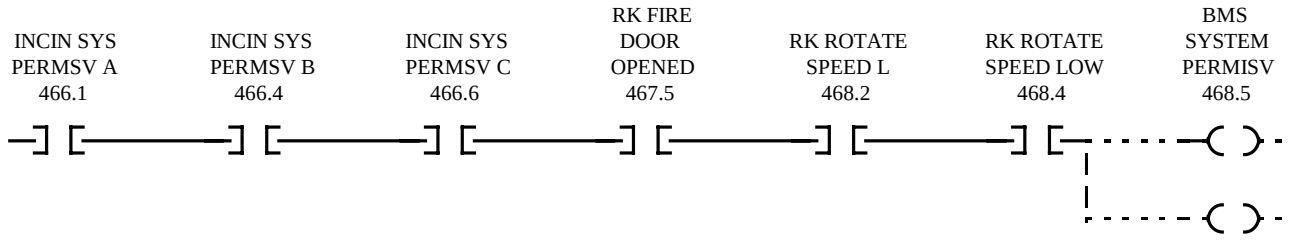

Figure 13 BMS Permissive Relay

HVAC

A relay signal is sent from the Main FACP to the make-up air fan when fire is detected in the Incinerator and Box Handling Areas (Zones 3 & 4) This signal secures the make-up air fan and secures fresh air supply to the air-conditioned portions of Building 261-H. A fire detected in Zone 5 or 6 also secures the toilet exhaust fan and Control Building HVAC System.

Solid Waste Handling

A hardwired signal from the Main FACP secures the conveyors when a fire is detected in the Box Handling Area.

INTEGRATED PLANT OPERATIONS

ELO 1.09	**EXPLAIN the normal operations of the Fire Protection/Fire Detection and Alarm System to include actions for spurious alarms.**

Normal Operations

Under normal conditions, the Fire Protection System is ready for service (Wet Pipe, Dry Pipe, and Foam Deluge valves reset and pressurized on the water supply side) and ready for actuation if required. No operator actions other than rounds inspections are required.

System Startup

The Wet Pipe System should be walked down to verify integrity (sprinkler heads) prior to being placed in service. This is in addition to required valve lineups. Inspections would include supply water header pressure at $\geq$95 psig and $\leq$150 psig, dry pipe air header pressure at from 35 to 45 psig, and foam concentrate tank level full (sight glass indication).

Maintaining Normal Operations

For the FDAS, normal operating condition is "NO ALARMS ACTIVE". FP system condition and valve positions are monitored, as well as FDAS system condition and detector status. No operator actions are required.

Spurious alarms, warnings, and trouble indications will occasionally occur for various reasons. The operator should be familiar with Alarm Response Procedures to respond to these alarms and warnings. In addition to the actions listed in the current ARPs, the operator will also access the FACP to acknowledge the alarm, or warning to silence the signal. When this is done, it is paramount that the operator does not improperly press the Alarm Off and leave the alarm panel silenced. This would remove the ability of the FACP to subsequently sound, and secures the signal to the Autoterm. The operator should only depress the Alarm Acknowledge.

If depressing the Alarm Acknowledge does not clear the alarm bell, this may indicate the signal may be due to a trouble condition. The operator should check the panel indication again to verify. The Trouble Off should be depressed to silence the signal if this is the case. When the trouble fault is subsequently cleared, the trouble signal will again return until the operator unlatches the Trouble Off button.

ELO 2.01 DESCRIBE the requirements for Infrequent/Abnormal operations of the Fire Detection/Fire Suppression and Alarm System (FP/FDAS).

Infrequent operations

Surveillances

Periodic testing of the fire protection system components will be required to demonstrate operability. Testing methods and frequency will conform to Site Fire Department requirements. Tests will include:

Wet, dry, and foam deluge valves:

- Flow Tests at Inspector Test Stations - These will actuate the associated system control valve(s) and require that the valves be reset.
- Main Drain Test - Verifies flow and pressure from the main drain without actuating the control valve.
- Alarm (pressure switch) Test - using alarm test valve.
- Low and High Air Pressure Alarm Test (Dry valves) - verifies air supervisory high and low alarms

FDAS:

- Loss of Electrical Power - switch over to battery.
- Detector circuit continuity - no line breaks.
- Detector actuation and alarm - system integrity.

Any testing which removes the ability of a system to function requires impairment control in accordance with WSRC 2Q, Procedure 5.6, *Fire Protection Impairment Control and Compensatory Action*.

The foam tank level indicator is normally isolated since it is open to atmosphere at the top of the indicating tube. If the system were to actuate with the level indicator not isolated, concentrate would be forced upward out of the tube and would spill into the Foam House. Monthly verification of level will require the Foam Tank to be isolated. Prior to this level check, the controls for impairments must be initiated. This is because level stabilization will require approximately two (2) hours.

In addition to tests of system operability, periodic surveillances will monitor for proper location and operability of exit signs, emergency lighting, portable extinguishers, and fire exits. Monthly maintenance on portable extinguishers will also be performed.

Upon completion, all surveillances must be reviewed by the Fire Protection Coordinator.

Abnormal Operations

Impairments

The Fire Protection/Fire Detection and Alarm System is independent of any operating mode for the facility and will be in service for all operating modes. If not in service, other measures (fire watch, etc.) will be employed. No changes in system configuration (lineup) or status should be made without prior notification, and approval of the SRS Fire Department and the Fire Protection Coordinator. If a condition occurs which changes the system status beyond the ability to correct (pipe break, system malfunction, etc.), this notification shall be made as soon as the problem is discovered. The impairment must be properly logged and tracked by the Fire Protection Coordinator. The entry in the logs will include methods used as compensatory measures. The responsibilities and requirements for control of these impairments can be found in WSRC 2Q, Procedure 5.6, *Fire Protection Impairment Control and Compensatory Action*.

The operator must be aware of the "normal" operation of equipment within assigned area of responsibility. Being familiar with those responsibilities will enable you to recognize any abnormal situation in a timely fashion. Some of the items which could impair the proper operation of the system are:

- Improperly positioned valves
- Improperly positioned switches
- Equipment blocking the integrity of fire barriers
- Damaged sensors or other equipment
- Extending a sprinkler system boundary by adding temporary fixtures
- Scaffolding or other blockage below a sprinkler system

Hot Work

The use of portable acetylene welding and cutting torches, electrical welding equipment, blow torches, propane torches, melting pots, portable furnaces and heaters, grinding, spark producing operation, and open flames of any kind is considered hot work. The responsibilities and requirements for control of hot work can be found in WSRC 2Q, Procedure 5.4, *Control of Hot Work and Hot Work Permits*. Although hot work is controlled in this manner, an alert watchstander can prevent potentially dangerous situations that may have been missed in the administrative review. Some situations in which hot work is prohibited without additional precautions and prior approval by the fire protection coordinator are:

- in buildings with sprinklers which are out of service
- where explosive atmospheres of gases, vapors, or dusts are present, or where an explosive atmosphere could develop from residues or accumulations in confined spaces
- in areas with high combustible fuel loading

- near storage of large quantities of exposed, readily ignitable material such as wood, paper, or rags.

Fire Watches and Fire Patrols

When an abnormal situations exists, such as Fire Protection System impairments or hot work, a fire watch may be designated to monitor an area or inspect a process. These personnel have significant responsibilities including providing initial alarm notification, suppression of incipient fires, and stopping work if unsafe conditions exist or develop. Prior to assignment as a fire watch or fire patrol, you must complete training and maintain qualification in accordance with WSRC 2Q.

System Shutdown

In the event of Fire Protection System actuation, the only way to stop water flow to the affected area is to close the manual isolation valve(s) to the actuated FP valve. This should only be done after it is verified by the SRS Fire Department that all fires are fully extinguished.

Summary

- Surveillances are periodically performed to measure Fire Protection System effectiveness.
- Impairments are controlled in accordance with WSRC 2Q, Procedure 5.6, *Fire Protection Impairment Control and Compensatory Action*.
- Hot work is controlled in accordance with WSRC 2Q, Procedure 5.4, *Control of Hot Work and Hot Work Permits*.
- Fire watches and fire patrols require diligence and alertness. Prior to accepting the duties of a fire watch or fire patrol, a watchstander must have completed the requisite training in accordance with WSRC 2Q.
- System shutdown following a fire must only occur after the fire has been confirmed as fully extinguished by the SRS Fire Department.